The movements and habits of climbing plants.

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CHAPTER V.

HOOK AND ROOT-CLIMBERS.—CONCLUDING REMARKS.

Plants climbing by the aid of hooks, or merely scrambling over other plants—Root-climbers, adhesive matter secreted by the rootlets—General conclusions with respect to climbing plants, and the stages of their development.

Hook-Climbers.—In my introductory remarks, I stated that, besides the two first great classes of climbing plants, namely, those which twine round a support, and those endowed with irritability enabling them to seize hold of objects by means of their petioles or tendrils, there are two other classes, hook-climbers and root-climbers. Many plants, moreover, as Fritz Müller has remarked,* climb or scramble up thickets in a still more simple fashion, without any special aid, excepting that their leading shoots are generally long and flexible. It may, however, be suspected from what follows, that these shoots in some cases tend to avoid the light. The few hook-climbers which I have observed, namely, *Galium aparine, Rubus australis,* and some climbing

* Journal of Linn. Soc. vol. ix. p. 348. Professor G. Jaeger has well remarked ('In Sachen Darwin's, insbesondere contra Wigand,' 1874, p. 106) that it is highly characteristic of climbing plants to produce thin, elongated, and flexible stems. He further remarks that plants growing beneath other and taller species or trees, are naturally those which would be developed into climbers; and such plants, from stretching towards the light, and from not being much agitated by the wind, tend to produce long, thin and flexible shoots.

Roses, exhibit no spontaneous revolving movement. If they had possessed this power, and had been capable of twining, they would have been placed in the class of Twiners; for some twiners are furnished with spines or hooks, which aid them in their ascent. For instance, the Hop, which is a twiner, has reflexed hooks as large as those of the *Galium;* some other twiners have stiff reflexed hairs; and *Dipladenia* has a circle of blunt spines at the bases of its leaves. I have seen only one tendril-bearing plant, namely, *Smilax aspera,* which is furnished with reflexed spines; but this is the case with several branch-climbers in South Brazil and Ceylon; and their branches graduate into true tendrils. Some few plants apparently depend solely on their hooks for climbing, and yet do so efficiently, as certain palms in the New and Old Worlds. Even some climbing Roses will ascend the walls of a tall house, if covered with a trellis. How this is effected I know not; for the young shoots of one such Rose, when placed in a pot in a window, bent irregularly towards the light during the day and from the light during the night, like the shoots of any common plant; so that it is not easy to understand how they could have got under a trellis close to the wall.*

* Professor Asa Gray has explained, as it would appear, this difficulty in his review (American Journal of Science, vol. xl. Sept. 1865, p. 282) of the present work. He has observed that the strong summer shoots of the Michigan rose (*Rosa setigera*) are strongly disposed to push into dark crevices and away from the light, so that they would be almost sure to place themselves under a trellis. He adds that the lateral shoots, made on the following spring, emerged from the trellis as they sought the light.

Root-climbers.—A good many plants come under this class, and are excellent climbers. One of the most remarkable is the *Marcgravia umbellata*, the stem of which in the tropical forests of South America, as I hear from Mr. Spruce, grows in a curiously flattened manner against the trunks of trees; here and there it puts forth claspers (roots), which adhere to the trunk, and, if the latter be slender, completely embrace it. When this plant has climbed to the light, it produces free branches with rounded stems, clad with sharp-pointed leaves, wonderfully different in appearance from those borne by the stem as long as it remains adherent. This surprising difference in the leaves, I have also observed in a plant of *Marcgravia dubia* in my hothouse. Root-climbers, as far as I have seen, namely, the Ivy (*Hedera helix*), *Ficus repens*, and *F. barbatus*, have no power of movement, not even from the light to the dark. As previously stated, the *Hoya carnosa* (Asclepiadaceæ) is a spiral twiner, and likewise adheres by rootlets even to a flat wall. The tendril-bearing *Bignonia Tweedyana* emits roots, which curve half round and adhere to thin sticks. The *Tecoma radicans* (Bignoniaceæ), which is closely allied to many spontaneously revolving species, climbs by rootlets; nevertheless, its young shoots apparently move about more than can be accounted for by the varying action of the light.

I have not closely observed many root-climbers, but can give one curious fact. *Ficus repens* climbs up a wall just like Ivy; and when the young rootlets are made to press lightly on slips of glass, they emit after about a week's interval, as I observed several times, minute drops of clear fluid, not in the least milky like that exuded from a wound. This fluid is slightly viscid, but cannot be drawn out into threads. It has the remarkable property of not soon drying; a drop, about the size of half a pin's head, was slightly spread out on glass, and I scattered on it some minute grains of sand. The glass was left exposed in a drawer during hot and dry weather, and if the fluid had been water, it would certainly have dried in a few minutes; but it remained fluid, closely surrounding each grain of sand, during 128 days: how much longer it would have remained I cannot say. Some other rootlets were left in contact with the glass for about ten days or a fortnight, and the drops of secreted fluid were now rather larger, and so viscid that they could be drawn out into threads. Some other rootlets were left in contact during twenty-three days, and these were firmly cemented to the glass. Hence we may conclude that the rootlets first secrete a slightly viscid fluid, subsequently absorb the watery parts, (for we have seen that the fluid will not dry by itself,) and ultimately leave a cement. When the rootlets were torn from the glass, atoms of yellowish matter were left on it, which were partly dissolved by a drop of bisulphide of carbon; and this extremely volatile fluid was rendered very much less volatile by what it had dissolved.

As the bisulphide of carbon has a strong power of softening indurated caoutchouc, I soaked in it during a short time several rootlets of a plant which had grown up a plaistered wall; and I then found many extremely thin threads of transparent, not viscid, excessively elastic matter, precisely like caoutchouc, attached to two sets of rootlets on the same branch. These threads proceeded from the bark of the rootlet at one end, and at the other end were firmly attached to particles of silex or mortar from the wall. There could be no mistake in this observation, as I played with the threads for a long time under the microscope, drawing them out with my dissecting-needles and letting them spring back again. Yet I looked repeatedly at other rootlets similarly treated, and could never again discover these elastic threads. I therefore infer that the branch in question must have been slightly moved from the wall at some critical period, whilst the secretion was in the act of drying, through the absorption of its watery parts. The genus *Ficus* abounds with caoutchouc, and we may conclude from the facts just given that this substance, at first in solution and ultimately modified into an unelastic cement,* is used by the *Ficus repens* to cement its rootlets to any surface which it ascends. Whether other plants, which climb by their rootlets, emit any cement I do not know; but the rootlets of the

* Mr. Spiller has recently shown (Chemical Society, Feb. 16, 1865), in a paper on the oxidation of india-rubber or caoutchouc, that this substance, when exposed in a fine state of division to the air, gradually becomes converted into brittle, resinous matter, very similar to shell-lac.

Ivy, placed against glass, barely adhered to it, yet secreted a little yellowish matter. I may add, that the rootlets of the *Marcgravia dubia* can adhere firmly to smooth painted wood.

Vanilla aromatica emits aërial roots a foot in length, which point straight down to the ground. According to Mohl (p. 49), these crawl into crevices, and when they meet with a thin support, wind round it, as do tendrils. A plant which I kept was young, and did not form long roots; but on placing thin sticks in contact with them, they certainly bent a little to that side, in the course of about a day, and adhered by their rootlets to the wood; but they did not bend quite round the sticks, and afterwards they re-pursued their downward course. It is probable that these slight movements of the roots are due to the quicker growth of the side exposed to the light, in comparison with the other side, and not because the roots are sensitive to contact in the same manner as true tendrils. According to Mohl, the rootlets of certain species of *Lycopodium* act as tendrils.*

* Fritz Müller informs me that he saw in the forests of South Brazil numerous black strings, from some lines to nearly an inch in diameter, winding spirally round the trunks of gigantic trees. At first sight he thought that they were the stems of twining plants which were thus ascending the trees; but he afterwards found that they were the aërial roots of a Philodendron which grew on the branches above. These roots therefore seem to be true twiners, though they use their powers to descend, instead of to ascend like twining plants. The aërial roots of some other species of Philodendron hang vertically downwards, sometimes for a length of more than fifty feet

Concluding Remarks on Climbing Plants.

Plants become climbers, in order, as it may be presumed, to reach the light, and to expose a large surface of their leaves to its action and to that of the free air. This is effected by climbers with wonderfully little expenditure of organized matter, in comparison with trees, which have to support a load of heavy branches by a massive trunk. Hence, no doubt, it arises that there are so many climbing plants in all quarters of the world, belonging to so many different orders. These plants have been arranged under four classes, disregarding those which merely scramble over bushes without any special aid. Hook-climbers are the least efficient of all, at least in our temperate countries, and can climb only in the midst of an entangled mass of vegetation. Root-climbers are excellently adapted to ascend naked faces of rock or trunks of trees; when, however, they climb trunks they are compelled to keep much in the shade; they cannot pass from branch to branch and thus cover the whole summit of a tree, for their rootlets require long-continued and close contact with a steady surface in order to adhere. The two great classes of twiners and of plants with sensitive organs, namely, leaf-climbers and tendril-bearers taken together, far exceed in number and in the perfection of their mechanism the climbers of the two first classes. Those which have the power of spontaneously revolving and of grasping objects with which they come in contact, easily pass from branch to branch, and securely ramble over a wide, sun-lit surface.

The divisions containing twining plants, leaf-climbers, and tendril-bearers graduate to a certain extent into one another, and nearly all have the same remarkable power of spontaneously revolving. Does this gradation, it may be asked, indicate that plants belonging to one subdivision have actually passed during the lapse of ages, or can pass, from one state to the other? Has, for instance, any tendril-bearing plant assumed its present structure without having previously existed as a leaf-climber or a twiner? If we consider leaf-climbers alone, the idea that they were primordially twiners is forcibly suggested. The internodes of all, without exception, revolve in exactly the same manner as twiners; some few can still twine well, and many others in an imperfect manner. Several leaf-climbing genera are closely allied to other genera which are simple twiners. It should also be observed, that the possession of leaves with sensitive petioles, and with the consequent power of clasping an object, would be of comparatively little use to a plant, unless associated with revolving internodes, by which the leaves are brought into contact with a support; although no doubt a scrambling plant would be apt, as Professor Jaeger has remarked, to rest on other plants by its leaves. On the other hand, revolving internodes, without any other aid, suffice to give the power of climbing; so that it seems probable that leaf-climbers were in most cases at first twiners, and subsequently became capable of grasping a support; and this, as we shall presently see, is a great additional advantage.

From analogous reasons, it is probable that all tendril-bearers were primordially twiners, that is, are the descendants of plants having this power and habit. For the internodes of the majority revolve; and, in a few species, the flexible stem still retains the capacity of spirally twining round an upright stick. Tendril-bearers have undergone much more modification than leaf-climbers; hence it is not surprising that their supposed primordial habits of revolving and twining have been more frequently lost or modified than in the case of leaf-climbers. The three great tendril-bearing families in which this loss has occurred in the most marked manner, are the Cucurbitaceæ, Passifloraceæ, and Vitaceæ. In the first, the internodes revolve; but I have heard of no twining form, with the exception (according to Palm, p. 29. 52) of *Momordica balsamina*, and this is only an imperfect twiner. In the two other families I can hear of no twiners; and the internodes rarely have the power of revolving, this power being confined to the tendrils. The internodes, however, of *Passiflora gracilis* have the power in a perfect manner, and those of the common Vine in an imperfect degree: so that at least a trace of the supposed primordial habit has been retained by some members of all the larger tendril-bearing groups.

On the view here given, it may be asked, Why have the species which were aboriginally twiners been converted in so many groups into leaf-climbers or tendril-bearers? Of what advantage has this been to them? Why did they not remain simple twiners? We can see several reasons. It might be an advantage to a plant to acquire a thicker stem, with short internodes bearing many or large leaves; and such stems are ill fitted for twining. Any one who will look during windy weather at twining plants will see that they are easily blown from their support; not so with tendril-bearers or leaf-climbers, for they quickly and firmly grasp their support by a much more efficient kind of movement. In those plants which still twine, but at the same time possess tendrils or sensitive petioles, as some species of Bignonia, Clematis, and Tropæolum, it can readily be observed how incomparably better they grasp an upright stick than do simple twiners. Tendrils, from possessing this power of grasping an object, can be made long and thin; so that little organic matter is expended in their development, and yet they sweep a wide circle in search of a support. Tendril-bearers can, from their first growth, ascend along the outer branches of any neighbouring bush, and they are thus always fully exposed to the light; twiners, on the contrary, are best fitted to ascend bare stems, and generally have to start in the shade. Within tall and dense tropical forests, twining plants would probably succeed better than most kinds of tendril-bearers; but the majority of twiners, at least in our temperate regions, from the nature of their revolving movement, cannot ascend thick trunks, whereas this can be affected by tendril-bearers if the trunks are branched or bear twigs, and by some species if the bark is rugged.

The advantage gained by climbing is to reach the light and free air with as little expenditure of organic matter as possible; now, with twining plants, the stem is much longer than is absolutely necessary; for instance, I measured the stem of a kidney-bean, which had ascended exactly two feet in height, and it was three feet in length: the stem of a pea, on the other hand, which had ascended to the same height by the aid of its tendrils, was but little longer than the height reached. That this saving of the stem is really an advantage to climbing plants, I infer from the species that still twine but are aided by clasping petioles or tendrils, generally making more open spires than those made by simple twiners. Moreover, the plants thus aided, after taking one or two turns in one direction, generally ascend for a space straight, and then reverse the direction of their spire. By this means they ascend to a considerably greater height, with the same length of stem, than would otherwise have been possible; and they do this with safety, as they secure themselves at intervals by their clasping petioles or tendrils.

We have seen that tendrils consist of various organs in a modified state, namely, leaves, flower-peduncles, branches, and perhaps stipules. With respect to leaves, the evidence of their modification is ample. In young plants of Bignonia the lower leaves often remain quite unchanged, whilst the upper ones have their terminal leaflets converted into perfect tendrils; in *Eccremocarpus* I have seen a single lateral branch of a tendril replaced by a perfect leaflet; in *Vicia sativa*, on the other hand, leaflets are sometimes replaced by tendril-branches; and many other such cases could be given. But he who believes in the slow modification of species will not be content simply to ascertain the homological nature of different kinds of tendrils; he will wish to learn, as far as is possible, by what actual steps leaves, flower-peduncles, &c., have had their functions wholly changed, and have come to serve merely as prehensile organs.

In the whole group of leaf-climbers abundant evidence has been given that an organ, still subserving the functions of a leaf, may become sensitive to a touch, and thus grasp an adjoining object. With several leaf-climbers the true leaves spontaneously revolve; and their petioles, after clasping a support grow thicker and stronger. We thus see that leaves may acquire all the leading and characteristic qualities of tendrils, namely, sensitiveness, spontaneous movement, and subsequently increased strength. If their blades or laminæ were to abort, they would form true tendrils. And of this process of abortion we can follow every step, until no trace of the original nature of the tendril is left. In *Mutisia clematis*, the tendril, in shape and colour, closely resembles the petiole of one of the ordinary leaves, together with the midribs of the leaflets, but vestiges of the laminæ are still occasionally retained. In four genera of the Fumariaceæ we can follow the whole process of transformation. The terminal leaflets of the leaf-climbing *Fumaria officinalis* are not smaller than the other leaflets; those of the leaf-climbing *Adlumia cirrhosa* are greatly reduced; those of *Corydalis claviculata* (a plant which may indifferently be called a leaf-climber or a tendril-bearer) are either reduced to microscopical dimensions or have their blades wholly aborted, so that this plant is actually in a state of transition; and, finally, in the *Dicentra* the tendrils are perfectly characterized. If, therefore, we could behold at the same time all the progenitors of *Dicentra,* we should almost certainly see a series like that now exhibited by the above-named three genera. In *Tropæolum tricolorum* we have another kind of passage; for the leaves which are first formed on the young stems are entirely destitute of laminæ, and must be called tendrils, whilst the later formed leaves have well-developed laminæ. In all cases the acquirement of sensitiveness by the mid-ribs of the leaves appears to stand in some close relation with the abortion of their laminæ or blades.

On the view here given, leaf-climbers were primordially twiners, and tendril-bearers (when formed of modified leaves) were primordially leaf-climbers. The latter, therefore, are intermediate in nature between twiners and tendril-bearers, and ought to be related to both. This is the case: thus the several leaf-climbing species of the Antirrhineæ, of Solanum, Cocculus, and Gloriosa, have within the same family and even within the same genus, relatives which are twiners. In the genus Mikania, there are leaf-climbing and twining species. The leaf-climbing species of Clematis are very closely allied to the tendril-bearing Naravelia. The Fumariaceæ include closely allied genera which are leaf-climbers and tendril-bearers. Lastly, a species of Bignonia is at the same time both a leaf-climber and a tendril-bearer; and other closely allied species are twiners.

Tendrils of another kind consist of modified flower-peduncles. In this case we likewise have many interesting transitional states. The common Vine (not to mention the *Cardiospermum*) gives us every possible gradation between a perfectly developed tendril and a flower-peduncle covered with flowers, yet furnished with a branch, forming the flower-tendril. When the latter itself bears a few flowers, as we know sometimes is the case, and still retains the power of clasping a support, we see an early condition of all those tendrils which have been formed by the modification of flower-peduncles.

According to Mohl and others, some tendrils consist of modified branches: I have not observed any such cases, and know nothing of their transitional states, but these have been fully described by Fritz Müller. The genus Lophospermum also shows us how such a transition is possible; for its branches spontaneously revolve and are sensitive to contact. Hence, if the leaves on some of the branches of the Lophospermum were to abort, these branches would be converted into true tendrils. Nor is there anything improbable in certain branches alone being thus modified, whilst others remained unaltered; for we have seen with certain varieties of *Phaseolus*, that some of the branches are thin, flexible, and twine, whilst other branches on the same plant are stiff and have no such power.

If we inquire how a petiole, a branch or flower-peduncle first became sensitive to a touch, and acquired the power of bending towards the touched side, we get no certain answer. Nevertheless an observation by Hofmeister* well deserves attention, namely, that the shoots and leaves of all plants, whilst young, move after being shaken. Kerner also finds, as we have seen, that the flower-peduncles of a large number of plants, if shaken or gently rubbed bend to this side. And it is young petioles and tendrils, whatever their homological nature may be, which move on being touched. It thus appears that climbing plants have utilized and perfected a widely distributed and incipient capacity, which capacity, as far as we can see, is of no service to ordinary plants. If we further inquire how the stems, petioles, tendrils, and flower-peduncles of climbing plants first acquired their power of spontaneously revolving, or, to speak more accurately, of successively bending to all points of the compass, we are again silenced, or at most can only remark that the power of moving, both spontaneously and from various stimulants, is far more

* Quoted by Cohn, in his remarkable memoir, "Contractile Gewebe im Pflanzenreiche," 'Abhandl. der Schlesischen Gesell. 1861, Heft i. s. 35.

common with plants, than is generally supposed to be the case by those who have not attended to the subject. I have given one remarkable instance, namely that of the *Maurandia semperflorens*, the young flower-peduncles of which spontaneously revolve in very small circles, and bend when gently rubbed to the touched side; yet this plant certainly does not profit by these two feebly developed powers. A rigorous examination of other young plants would probably show slight spontaneous movements in their stems, petioles or peduncles, as well as sensitiveness to a touch.* We see at least that the *Maurandia* might, by a little augmentation of the powers which it already possesses, come first to grasp a support by its flower-peduncles, and then, by the abortion of some of its flowers (as with *Vitis* or *Cardiospermum*), acquire perfect tendrils.

There is one other interesting point which deserves notice. We have seen that some tendrils owe their origin to modified leaves, and others to modified flower-peduncles; so that some are foliar and others axial in their nature. It might therefore have been expected that they would have presented some difference in function. This is not the case. On the contrary, they

* Such slight spontaneous movements, I now find, have been for some time known to occur, for instance with the flower-stems of *Brassica napus* and with the leaves of many plants: Sachs' 'Text-Book of Botany' 1875, pp. 766, 785. Fritz Müller also has shown in relation to our present subject ('Jenaischen Zeitschrift,' Bd. V. Heft 2, p. 133) that the stems, whilst young, of an Alisma and of a Linum are continually performing slight movements to all points of the compass, like those of climbing plants.

present the most complete identity in their several characteristic powers. Tendrils of both kinds spontaneously revolve at about the same rate. Both, when touched, bend quickly to the touched side, and afterwards recover themselves and are able to act again. In both the sensitiveness is either confined to one side or extends all round the tendril. Both are either attracted or repelled by the light. The latter property is seen in the foliar tendrils of *Bignonia capreolata* and in the axial tendrils of *Ampelopsis*. The tips of the tendrils in these two plants become, after contact, enlarged into discs, which are at first adhesive by the secretion of some cement. Tendrils of both kinds, soon after grasping a support, contract spirally; they then increase greatly in thickness and strength. When we add to these several points of identity the fact that the petiole of *Solanum jasminoides*, after it has clasped a support, assumes one of the most characteristic features of the axis, namely, a closed ring of woody vessels, we can hardly avoid asking, whether the difference between foliar and axial organs can be of so fundamental a nature as is generally supposed? *

We have attempted to trace some of the stages in the genesis of climbing plants. But, during the endless fluctuations of the conditions of life to which all organic beings have been exposed, it might be expected that some climbing plants would have lost

* Mr. Herbert Spencer has recently argued ('Principles of Biology,' 1865, p. 37 *et seq.*) with much force that there is no fundamental distinction between the foliar and axial organs of plants.

the habit of climbing. In the cases given of certain South African plants belonging to great twining families, which in their native country never twine, but reassume this habit when cultivated in England, we have a case in point. In the leaf-climbing *Clematis flammula*, and in the tendril-bearing Vine, we see no loss in the power of climbing, but only a remnant of the revolving power which is indispensable to all twiners, and is so common as well as so advantageous to most climbers. In *Tecoma radicans*, one of the Bignoniaceæ, we see a last and doubtful trace of the power of revolving.

With respect to the abortion of tendrils, certain cultivated varieties of *Cucurbita pepo* have, according to Naudin,* either quite lost these organs or bear semi-monstrous representatives of them. In my limited experience, I have met with only one apparent instance of their natural suppression, namely, in the common bean. All the other species of *Vicia*, I believe, bear tendrils; but the bean is stiff enough to support its own stem, and in this species, at the end of the petiole, where, according to analogy, a tendril ought to have existed, a small pointed filament projects, about a third of an inch in length, and which is probably the rudiment of a tendril. This may be the more safely inferred, as in young and unhealthy specimens of other tendril-bearing plants similar rudiments may occasionally be observed. In the bean

* Annales des Sc. Nat. 4th series, Bot. tom. vi. 1856, p. 31.

these filaments are variable in shape, as is so frequently the case with rudimentary organs; they are either cylindrical, or foliaceous, or are deeply furrowed on the upper surface. They have not retained any vestige of the power of revolving. It is a curious fact, that many of these filaments, when foliaceous, have on their lower surfaces, dark-coloured glands like those on the stipules, which excrete a sweet fluid; so that these rudiments have been feebly utilized.

One other analogous case, though hypothetical, is worth giving. Nearly all the species of *Lathyrus* possesses tendrils; but *L. nissolia* is destitute of them. This plant has leaves, which must have struck every one with surprise who has noticed them, for they are quite unlike those of all common papilionaceous plants, and resemble those of a grass. In another species, *L. aphaca*, the tendril, which is not highly developed (for it is unbranched, and has no spontaneous revolving-power), replaces the leaves, the latter being replaced in function by large stipules. Now if we suppose the tendrils of *L. aphaca* to become flattened and foliaceous, like the little rudimentary tendrils of the bean, and the large stipules to become at the same time reduced in size, from not being any longer wanted, we should have the exact counterpart of *L. nissolia*, and its curious leaves are at once rendered intelligible to us.

It may be added, as serving to sum up the foregoing views on the origin of tendril-bearing plants, that *L. nissolia* is probably descended from a plant which was primordially a twiner; this then became a leaf-climber, the leaves being afterwards converted by degrees into tendrils, with the stipules greatly increased in size through the law of compensation.* After a time the tendrils lost their branches and became simple; they then lost their revolving-power (in which state they would have resembled the tendrils of the existing *L. aphaca*), and afterwards losing their prehensile power and becoming foliaceous would no longer be thus designated. In this last stage (that of the existing *L. nissolia*) the former tendrils would reassume their original function of leaves, and the stipules which were recently much developed being no longer wanted, would decrease in size. If species become modified in the course of ages, as almost all naturalists now admit, we may conclude that *L. nissolia* has passed through a series of changes, in some degree like those here indicated.

The most interesting point in the natural history of climbing plants is the various kinds of movement which they display in manifest relation to their wants. The most different organs—stems, branches, flower-peduncles, petioles, mid-ribs of the leaf and leaflets, and apparently aërial roots—all possess this power.

The first action of a tendril is to place itself in a proper position. For instance, the tendril of Cobæa

* Moquin-Tandon (Éléments de Tératologie, 1841, p. 156) gives the case of a monstrous bean, in which a case of compensation of this nature was suddenly effected; for the leaves completely disappeared and the stipules grew to an enormous size.

first rises vertically up, with its branches divergent and with the terminal hooks turned outwards; the young shoot at the extremity of the stem is at the same time bent to one side, so as to be out of the way. The young leaves of Clematis, on the other hand, prepare for action by temporarily curving themselves downwards, so as to serve as grapnels.

Secondly, if a twining plant or a tendril gets by any accident into an inclined position, it soon bends upwards, though secluded from the light. The guiding stimulus no doubt is the attraction of gravity, as Andrew Knight showed to be the case with germinating plants. If a shoot of any ordinary plant be placed in an inclined position in a glass of water in the dark, the extremity will, in a few hours, bend upwards; and if the position of the shoot be then reversed, the downward-bent shoot reverses its curvature; but if the stolon of a strawberry, which has no tendency to grow upwards, be thus treated, it will curve downwards in the direction of, instead of in opposition to, the force of gravity. As with the strawberry, so it is generally with the twining shoots of the *Hibbertia dentata*, which climbs laterally from bush to bush; for these shoots, if placed in a position inclined downwards, show little and sometimes no tendency to curve upwards.

Thirdly, climbing plants, like other plants, bend towards the light by a movement closely analogous to the incurvation which causes them to revolve, so that their revolving movement is often accelerated or retarded in travelling to or from the light. On the other hand, in a few instances tendrils bend towards the dark.

Fourthly, we have the spontaneous revolving movement which is independent of any outward stimulus, but is contingent on the youth of the part, and on vigorous health; and this again of course depends on a proper temperature and other favourable conditions of life.

Fifthly, tendrils, whatever their homological nature may be, and the petioles or tips of the leaves of leaf-climbers, and apparently certain roots, all have the power of movement when touched, and bend quickly towards the touched side. Extremely slight pressure often suffices. If the pressure be not permanent, the part in question straightens itself and is again ready to bend on being touched.

Sixthly, and lastly, tendrils, soon after clasping a support, but not after a mere temporary curvature, contract spirally. If they have not come into contact with any object, they ultimately contract spirally, after ceasing to revolve; but in this case the movement is useless, and occurs only after a considerable lapse of time.

With respect to the means by which these various movements are effected, there can be little doubt from the researches of Sachs and H. de Vries, that they are due to unequal growth; but from the reasons already assigned, I cannot believe that this explanation applies to the rapid movements from a delicate touch.

Finally, climbing plants are sufficiently numerous to form a conspicuous feature in the vegetable kingdom, more especially in tropical forests. America, which so abounds with arboreal animals, as Mr. Bates remarks, likewise abounds according to Mohl and Palm with climbing plants; and of the tendril-bearing plants examined by me, the highest developed kinds are natives of this grand continent, namely, the several species of *Bignonia, Eccremocarpus, Cobæa,* and *Ampelopsis.* But even in the thickets of our temperate regions the number of climbing species and individuals is considerable, as will be found by counting them. They belong to many and widely different orders. To gain some rude idea of their distribution in the vegetable series, I marked, from the lists given by Mohl and Palm (adding a few myself, and a competent botanist, no doubt, could have added many more), all those families in Lindley's 'Vegetable Kingdom' which include twiners, leaf-climbers, or tendril-bearers. Lindley divides Phanerogamic plants into fifty-nine Alliances; of these, no less than thirty-five include climbing plants of the above kinds, hook and root-climbers being excluded. To these a few Cryptogamic plants must be added. When we reflect on the wide separation of these plants in the series, and when we know that in some of the largest, well-defined orders, such as the Compositæ, Rubiaceæ, Scrophulariaceæ, Liliaceæ, &c., species in only two or three genera have the power of climbing, the conclusion is forced on our minds that the capacity of revolving, on which most climbers depend, is inherent, though undeveloped, in almost every plant in the vegetable kingdom.

It has often been vaguely asserted that plants are distinguished from animals by not having the power of movement. It should rather be said that plants acquire and display this power only when it is of some advantage to them; this being of comparatively rare occurrence, as they are affixed to the ground, and food is brought to them by the air and rain. We see how high in the scale of organization a plant may rise, when we look at one of the more perfect tendril-bearers. It first places its tendrils ready for action, as a polypus places its tentacula. If the tendril be displaced, it is acted on by the force of gravity and rights itself. It is acted on by the light, and bends towards or from it, or disregards it, whichever may be most advantageous. During several days the tendrils or internodes, or both, spontaneously revolve with a steady motion. The tendril strikes some object, and quickly curls round and firmly grasps it. In the course of some hours it contracts into a spire, dragging up the stem, and forming an excellent spring. All movements now cease. By growth the tissues soon become wonderfully strong and durable. The tendril has done its work, and has done it in an admirable manner.